Perpendicular Magnetic Anisotropy and Low Saturation Magnetization in $[Pt/(Co,Cu)]_6$ Multilayers

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Due to their potential application to magnetic random access memory (MRAM), magnetic thin films with perpendicular magnetic anisotropy (PMA) have recently attracted a lot of research interests. With its role of determining the lowest cell size in MRAM, the strength of PMA is probably one of the most important magnetic parameters in these magnetic thin films. Considering that magnetostatic interactions are expected to be very strong in very high density MRAM, saturation magnetization (M_s) can be another important magnetic parameter, particularly for the pinned structure. This study deals with $[Pt/(Co,Cu)]_6$ multilayers with a low M_s value. The stacks with the structure of Ta/Pt/Ru/[Pt (0.2 nm)/ $Co_{100-x}Cu_x(t_{CoCu})]_6$/Ru were fabricated on a Si/SiO_2 substrate using a UHV sputtering system. The following values were used for the Cu content in the (Co,Cu) layer (x) and the (Co,Cu) thickness (t_{CoCu}): x=0, 20, 40, 50 at.%; t_{CoCu}=0.4, 0.5, 0.6 nm. The as-deposited samples were annealed at two different temperatures of 300 and 500℃. All the multilayers fabricated in this study exhibit PMA both in the as-deposited state and after annealing. The results for M_s and the effective anisotropy energy density (K_{eff})are shown in Figs. 1(a) and (b), respectively, only for the multilayers with the largest t_{CoCu} (0.6 nm). Two key features are (1) the observation of very small values of M_s(～300 emu/cc) at large x values of 40 and 50 at.% and (2) the increase of K_{eff} after annealing at these compositions. Cross-sectional microstructures by high resolution transmission electron microscopy show that a layered structure formed in the as-deposited state transforms into a bulk structure after annealing at 500℃, indicating that the origin of PMA of the annealed samples results from a bulk magnetocrystalline anisotropy, not from the interface effect.

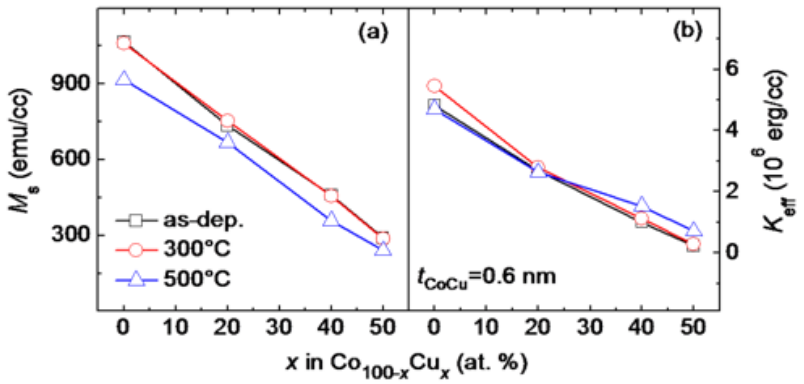

Figure 1. *Results for M_s and K_{eff} as a function of Cu content for the sample with t_{CoCu}= 0.6* nm.